What is claimed is:

1. An apparatus for preheating a substrate having a surface in order to perform laser thermal annealing of the substrate with an annealing radiation beam that is not substantially absorbed by the substrate at room temperature, the apparatus comprising:

a preheating radiation source adapted to emit preheating radiation that is substantially absorbed by the substrate at room temperature;

a relay lens adapted to receive the preheating radiation and form a preheating radiation beam that forms a first image at the substrate, wherein the first image is scanned over the substrate surface to preheat a portion of the surface that is in front of or that partially overlaps with a scanned second image formed by the annealing radiation beam; and

a recycling optical system arranged to receive preheating radiation reflected from the substrate and direct the reflected preheating radiation back to the substrate as a recycled radiation beam.

2. The apparatus of claim 1, wherein the recycling optical system includes a collecting/focusing lens and a corner cube reflector.

3. The apparatus of claim 2, wherein the recycled radiation beam and the preheating radiation beam have respective incident angles, the recycling optical system has an optical axis, and wherein the corner cube reflector is displaced relative to the optical axis so as to at least partially separate the incidence angles of the recycled and preheating radiation beams.

4. The apparatus of claim 1, wherein the recycling optical system includes a telecentric relay and a diffraction grating.

5. An apparatus for preheating a substrate having a surface in order to perform laser thermal annealing of the substrate with an annealing radiation beam that is not substantially absorbed by the substrate at room temperature, the apparatus comprising:

first and second preheating optical systems each arranged to irradiate a portion of the substrate with respective first and second preheating radiation beams each having a wavelength that is substantially absorbed by the substrate at room temperature; and

wherein said first and second preheating radiation beams form respective first and second scanned images that are maintained ahead of a third scanned image formed by the annealing radiation beam when the preheating radiation beams and the annealing radiation beam are scanned relative to the substrate surface.

6. The apparatus of claim 5, wherein first and second preheating radiation beams are p-polarized and intercept the substrate surface at an angle that minimizes variation in absorption from structures present on the substrate surface.

7. The apparatus of claim 5, wherein first and second preheating radiation beams have equal and opposite incident angles.

8. An apparatus for preheating a substrate having a surface in order to perform laser thermal annealing of the substrate with an annealing radiation beam that is not substantially absorbed by the substrate at room temperature, the apparatus comprising:

multiple preheating optical systems each arranged to irradiate a portion of the substrate with multiple preheating radiation beams each having a wavelength that is substantially absorbed by the substrate at room temperature; and

wherein said multiple preheating radiation beams form respective images that are maintained ahead of an annealing radiation beam image when the preheating radiation beams and the annealing radiation beam are scanned relative to the substrate surface.

9. A method of preheating a substrate surface in order to perform laser thermal annealing with an annealing radiation beam that is not substantially absorbed by the substrate at room temperature, the method comprising:

irradiating a portion of the substrate with a preheating radiation beam;

receiving preheating radiation that is reflected from the portion of the substrate; and

directing the received radiation back to the portion of the substrate.

10. The method of claim 9, wherein directing the received radiation back to the portion of the substrate includes reflecting the received radiation with a corner cube reflector.

11. The method of claim 9, wherein directing the received radiation back to the portion of the substrate includes reflecting the received radiation from a roof mirror and a cylindrical mirror.

12. The method of claim 9, wherein directing the received radiation back to the portion of the substrate includes diffracting the received radiation with a diffraction grating that is tilted with respect to the received radiation so that the radiation directed back to the substrate is kept in focus across the substrate surface.

13. A method of preheating a substrate having a surface in order to perform laser thermal annealing of the substrate with an annealing radiation beam that is not substantially absorbed by the substrate at room temperature, the method comprising:

irradiating a first portion of the substrate with first and second preheating radiation beams each having a wavelength that is substantially absorbed by the substrate at room temperature; and

maintaining the first portion in front of a second portion of the substrate surface irradiated by an annealing radiation beam when the preheating radiation beams and the annealing radiation beams are scanned relative to the substrate surface such that the annealing radiation beam is substantially absorbed by the substrate when it encounters the heated first portion.

14. The method of claim 14, wherein the first and second preheating radiation beams have the same wavelength.

15. The method of claim 13, wherein the annealing radiation beam is incident the substrate at Brewster's angle, and wherein the preheating radiation beams are each incident the substrate over a range of angles that includes a central angle, wherein the central angle for each range of angles is different than Brewster's angle.

16. The method of claim 13, wherein the annealing radiation beam and the preheating radiation beams are incident the substrate at respective angles that minimize variations in absorption from structures present on the substrate surface.

17. The method of claim 13, including forming the first and second preheating radiation beams to each have i) a numerical aperture at the substrate between 0.15 and 0.5, and ii) an incident angle of about 52°.